Effect of Different Cervical Muscles Training Protocols on Neck Pain and Disability in Smartphone Addicted Users

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Neck pain (NP) is a common symptom among smartphone addicted users and it is associated with increasing disability. This study was conducted to compare the effect of different muscles training protocols on NP and disability in smartphone addicted users. Random assignment of participants was into 3 equal groups. Group A received deep cervical flexors (DCF) training exercises, group B received McKenzie neck training exercises and group C received combined training. Treatment was given for 4 weeks. We evaluated NP using visual analog scale (VAS), while neck disability (ND) was evaluated using neck disability index (NDI), Pre-treatment ANOVA showed no significant differences in NP (P=0.920) and ND (P=0.972). On the other hand, post-treatment, there were statistically significant differences among the 3 groups in NP (P<0.001) and ND (P=0.006). The percentage of reduction in NP was 38.46% for group A, 40.92% for group B and 58.47% for group C. While the percentage of reduction in ND was 33.55% for group A, 35.19% for group B and 42.67% for group C. Cervical training protocol that include both DCF muscle training and McKenzie neck training was more effective in reducing NP and ND than the protocols that used either DCF muscle training or McKenzie neck training alone in smartphone addicted users.

Keywords: Neck pain, neck disability index, smartphone, McKenzie training

INTRODUCTION
Population surveys and primary care records showed neck pain (NP) as the second widespread musculoskeletal complaint, affecting approximately 67% of individuals at some point of their time in their lifetime [Hoy et al. 2010]. Neck pain forms a well-known burden to the health and economic systems. It is associated with significant disability in the general population [Driessen et al. 2012]. Estimated annual incidence of NP, based on the currently available evidence, is 10.4% to 21.3%. Higher incidences are generally expected in office and computer workers [Hoy et al. 2014]. Mechanical neck pain (MNP) is a term used to identify pain originating from soft tissue, muscles, faulty mechanics and posture in the absence of a specific underlying disease or disorder [De Zoete et al. 2020]. Apart from traumas, poor posture is the primary cause of MNP. Poor postures lead to abnormal stress levels to be imposed onto neck muscles and soft tissues responsible for head control. Persistent NP is frequently caused by
inadequate postural compensations to stresses [Sterling, 2009].

A smartphone is one of the most popular devices among adolescents in our digital society. The last few years witnessed a progressive increase in the numbers of smartphone users' worldwide [Namwongsa et al. 2018]. This increment on the number of smartphone users has been associated with an increasing focus on musculoskeletal problems as a consequence of the overuse of smartphones. Recent studies showed that smartphone users reported pain in the neck, shoulder, and thumb. Generally reported, the more extensive the use of the smartphone the more severe the related symptoms are [Eitiyipart et al. 2018].

The usual mode of use of smartphones is using either one hand or both to handle them, mostly at a height lower than level of the eyes, and using thumbs to contact the touchscreens [Lee et al. 2015]. A relation was shown between development and/or progress of postural abnormalities as those of forward head posture, slouched back, and rounded shoulders with the duration of smartphone use [So and Woo, 2014].

Maintaining faulty postures for long time causes soft tissues creep and deformation, and possibly altering physicochemical features of neck ligaments and the facet joints; for instance, a long standing forwards head posture may result in injuries of different spinal column structures of the cervical as well as the lumbar spines [Lee et al. 2016]. Furthermore, exaggerated neck flexion posture during static and dynamic situations had relevance to higher incidence of NP. In particular, sustained neck flexion causes increased stresses on the neck, resulting in increased muscular fatigue in the neck muscles [Amiri et al., 2017].

One of the neuromuscular defects from NP is the decreased or late activation of the deep cervical flexor (DCF) muscles [Jull et al. 2009]. Deep cervical flexor training focused therapy shows promising outcomes concerning reduction of both pain and disability [Suvarnnato et al. 2019 and Bobos et al. 2016]. Conservative treatment methods for NP in general practice include analgesic, rest or referral to a physical therapist that give passive treatment such as massage, interferential current or heat application and active treatment such as exercises therapies. The McKenzie method was frequently used as a treatment mechanical spinal disorder [Kim et al. 2019]. The McKenzie protocol has been commonly utilized in back conditions, while there is limited data regarding its effectiveness in the treatment of NP [Clare et al., 2004].

Although reports showed that DCF training protocol and McKenzie training protocol relief neck pain and reduce neck disability [Suvarnnato et al., 2019 and Kim et al. 2019]. Unfortunately, it is unknown which protocol is better than the other in relieving neck pain and neck disability. Also, it is unclear whether a combination protocol including both of them would be better than either intervention alone in terms of controlling neck pain and disability?

Therefore, this study was conducted to compare the effect of different cervical muscles training protocols on neck pain and neck disability in smartphone addicted users.

MATERIALS AND METHODS

Participants

Sixty subjects who suffered self-reported MNP related to prolonged smartphone usage were invited to participate in this study from Al-Qurayyat General Hospital at Al-Jouf Region, KSA. Their age was ranged from (18 to 26) years old, with the following inclusion criteria: using a smartphone for more than one year, complaining of neck pain while using a smartphone, individuals were addicted to smartphone according to smartphone addiction scale (SAS) [Kong et al. 2017 and Kee et al. 2016]. The smartphone addiction score was taken where 31 is cut off for males and 33 for females according to SAS [Kwon et al. 2013].

Subjects were excluded if they had the neurological or musculoskeletal disease, vestibular system problems, previous trauma or fracture around the cervical region and any deformities in the cervical or shoulder regions. Each participant was asked to sign a written informed consent in accordance with the Declaration of Helsinki before the beginning of the study. The research ethical committee provided ethical approval registered with the national committee for bioethics (NCBE) NO: H-13-S-071.

The study was a pre-test post-test randomized clinical trial. Randomization was done using a random number generator software (Random.org). Where 3 independent groups of 20 numbers each were created from the range of numbers 1-60 without repetition, a blind draw was carried out to select which set of numbers would represent each of the study groups. Subjects who were eligible to participate and provided consent were asked to select a number in an opaque envelope. According to this concealed selection each subject was allocated in the group to which his number belongs.
Outcome measures

Smartphone addiction

The Arabic SAS short version is a self-reporting scale used to assess smartphone addiction pre-treatment. The Arabic version of SAS was introduced to the participants. It consists of 10 items, subjects were asked to answer on a six-point Likert scale based on their level of agreement. Arabic SAS short version is a reliable (Cronbach’s alpha = 0.87) and valid measurement tool for the evaluation of smartphone addiction [Sfendla et al. 2018 and Kwon et al. 2013].

Pain intensity

Visual analogue scale (VAS) was used to assess the present pain intensity pre and post-treatment. VAS is a 10-cm straight line labeled “no pain” at one end “the worst pain” at the other. It is valid and reliable for pain assessment [Bird et al., 2016 and Boonstra et al. 2008].

Neck disability

The Arabic version of neck disability index (NDI) which consists of 10 items, 50 points index questionnaire was used to assess how neck pain and other symptoms affect patients’ function pre and post-treatment. The NDI scale was reported as a reliable (Cronbach’s alpha = 0.89) and valid method to quantify patients’ self-rated disability in cases of neck pain [Shaheen et al. 2013].

Procedures

Subjects in group A received deep cervical flexors training protocol. The subjects assumed the crook lying position and clasping both hands on the back of the head and pressing their elbows down to stretch the pectoralis major muscle. Then, the subjects were asked to attach the chin to the neck (chin tucked), then gently raise their heads a few centimeters. Subjects were instructed to inhale and hold the position for 7 seconds then exhale then relax. Exercises were performed for three sets, each set consisted of 10 repetitions for a hold of 7 seconds followed by 10 seconds of rest [Lee et al. 2017].

Subjects in group B received McKenzie neck training protocol. They have performed three different types of exercises. Retraction and extension, retraction and lateral flexion with overpressure at the terminal range of motion (ROM) and retraction with rotation with overpressure at the end of ROM. Exercises were performed in sitting position, starting from the chin tuck position, repeated for ten times in each direction with holding each contraction for three seconds [Kage et al. 2016].

Subjects in group C received combined training protocol which consisted of DCF training for three alternative days and McKenzie neck training for the opposite three alternative days. Subjects in all groups were asked to faithfully follow the corrective instructions regarding to the smartphone use which were given to them, which includes: (1) Raise the phone up closer to the eye level, try to decrease neck flexion and keeping the head in a neutral position. (2) Use a supportive chair with armrest when using the phone for a long period of time. (3) Do not use the phone to one side of the body with the neck rotated or holding the phone between the ear and shoulder, it is better to use ear headphone. (4) Take frequent breaks to move your neck in all directions, and try to limit the device use to a maximum 20 minutes per session. All subjects were asked to perform the exercises which belongs each group, only after the instructions given to them by the therapist through a demonstration session. The exercises were performed once daily for four weeks.

Statistical analysis

Data analysis was carried out using SPSS for windows (Version 22). Mean and standard deviation were reported for patients' demographic data, as well as for outcome variables. Dependent t-test was used to assess pre-post mean differences within each of the three groups. Analysis of variance (ANOVA) was used to assess differences between mean values of the variables under investigation among the three groups. Tukey post-hoc test was used in case ANOVA showed significance. The significance level was set at alpha < 0.05 among the groups.

RESULTS

Results of ANOVA showed non-significant differences among patients in all groups regarding their demographic data (P>0.05), as shown in the table 1. The dependent t-test revealed significant (P<0.001) decrease in NP intensity and self-reported disability in the three groups under investigations post-treatment in comparison to the pre-treatment mean values. Also, the percentage of reduction in NP was 38.46% for group A, 40.92% for group B and 58.47% for group C. While the percentage of reduction in neck disability was 33.55% for group A, 35.19% for group B and 42.67% for group C as shown in the table 2.
Results of ANOVA showed non-significant intra-groups differences at pre-treatment assessment in NP (P= 0.920) and NDI (P= 0.972). While, at post-treatment assessment, there were significant intra-groups differences in NP (P<0.001) and NDI (P= 0.006) as shown in the table 3.

Table 3. Results of ANOVA among the three groups

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pre-treatment Mean ±SD</th>
<th>Post-treatment Mean ±SD</th>
<th>P-value</th>
<th>Percentage of improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck pain (VAS)</td>
<td>Group A: 5.33 ±1.20</td>
<td>3.28 ±0.72</td>
<td>P&lt;0.001</td>
<td>38.46%</td>
</tr>
<tr>
<td></td>
<td>Group B: 5.18 ±1.17</td>
<td>3.06 ±0.59</td>
<td>P&lt;0.001</td>
<td>40.92%</td>
</tr>
<tr>
<td></td>
<td>Group C: 5.25 ±1.13</td>
<td>2.18 ±0.65</td>
<td>P&lt;0.001</td>
<td>58.47%</td>
</tr>
<tr>
<td>Neck disability index</td>
<td>Group A: 19.85 ±2.34</td>
<td>13.19 ±1.95</td>
<td>P&lt;0.001</td>
<td>33.55%</td>
</tr>
<tr>
<td></td>
<td>Group B: 20.03 ±2.19</td>
<td>12.98 ±1.67</td>
<td>P&lt;0.001</td>
<td>35.19%</td>
</tr>
<tr>
<td></td>
<td>Group C: 19.94 ±2.67</td>
<td>11.43 ±1.82</td>
<td>P&lt;0.001</td>
<td>42.67%</td>
</tr>
</tbody>
</table>

*P< 0.05 Significant, ± SD = Standard Deviation

Tukey post hoc test revealed non-significant differences between groups A and B post-treatment in NP (P= 0.541) and NDI (P= 0.929). Alternatively, group C showed significantly better reduction in NP (P<0.001) compared to both groups A and B. Likewise, group C showed significant improvement in NDI compared to groups A (P=0.009), and B (P=0.024) respectively, as shown in the table 4.

Table 4. Tukey post hoc test among the three groups

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups pairs</th>
<th>Mean difference</th>
<th>P-value</th>
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</thead>
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<tr>
<td>Neck pain (VAS)</td>
<td>A versus B</td>
<td>0.22</td>
<td>0.541</td>
</tr>
<tr>
<td></td>
<td>A versus C</td>
<td>1.10</td>
<td>P&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>B versus C</td>
<td>0.88</td>
<td>P&lt;0.001</td>
</tr>
<tr>
<td>Neck disability index</td>
<td>A versus B</td>
<td>0.21</td>
<td>0.929</td>
</tr>
<tr>
<td></td>
<td>A versus C</td>
<td>1.76</td>
<td>P&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>B versus C</td>
<td>1.55</td>
<td>0.024</td>
</tr>
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</table>

DISCUSSION

The present study is a randomized clinical trial designed to compare the effect of different cervical muscles training protocols on NP and neck disability in smartphone addicted users. In the present study, the smartphone addicted users with NP underwent either DCF training protocol or McKenzie neck training protocol or combined exercises protocol for 4 weeks.

The measured outcomes were assessed before and 4 weeks after exercises training to check whether exercises may affect NP and disability. Outcomes revealed improvement of both NP and disability in all training protocols used in the present study after 4 weeks of exercises training.
Furthermore, the combined training protocol group showed a higher statistical significant reduction in NP and neck disability in comparison to the other training protocols while there was no significant difference between DCF training protocol and McKenzie training protocol regarding NP and neck disability.

Regarding NP intensity and neck disability, the results of the current study confirm the positive effects of the DCF exercises in NP reduction and neck function enhancement. Our results were in agreement with Bobos et al., (2016) who showed that specific DCF training programs reduced neck pain and disability. Also, Jull et al. (2009) showed that increased activation of DCF muscles have shown to decrease neck pain and disability in chronic NP. Moreover, previous studies regarding NP also demonstrated that DCF muscles strengthening exercises successfully decreased NP and disability in patients with chronic NP. Also, the NDI showed that DCF training enhanced the functional status following a 4-weeks exercises program [Kim and Kwag, 2016 and Lee et al., 2013].

The current study also confirmed the positive effect of McKenzie training protocol in reducing NP and neck disability levels. Our results were in agreement with Neeraj and Verma (2016) who showed a significant reduction of NP following McKenzie treatment protocol and concluded that the McKenzie protocol has been found to be more beneficial than the isometric strengthening exercises. Also, Aziz et al. (2016) reported a significant reduction of NP in students who applied McKenzie exercises. Moreover, the application of McKenzie cervical protocol resulted in improved symptoms and function in patients with non-specific NP [Diab et al. 2016].

Within the available literature and to the best of our knowledge, there were no similar studies concerning the area of the cervical region that investigated the combined effect of both DCF training and McKenzie training on non-specific NP. The higher statistical significant improvement effect that was reported in the combined training protocol group could be attributed to the strengthening effect for the weakened muscles and thereby improved the muscle performance [Kashfi et al. 2019].

Increasing in the cervical angle following DCF training could improve the cervical posture and decrease the stress on the cervical spine [Kage et al. 2016]. Also, marked modifications in the cognitive and sensory perception of pain as a result of the exercises training could improve cervical kinesthetic sense which improved neck stability [Reddy et al. 2019].

The results of the current study suggest that treatment protocol for NP and neck disability in smartphone addicted users should include both DCF muscles training and McKenzie neck training for achievement of the best clinical results. Furthermore, following the corrective instructions regarding smartphone use will be more helpful during treatment.

**Limitations**

Subjects in this study were recruited from only one region, Al-Quwayrat Region, Saudi Arabia and it is unlikely that this could be representative of all Saudi Arabia populations. Thus generalization of the results to the whole Saudi Arabia populations may be limited. Also it was difficult to control the participants' activities.

**CONCLUSION**

Cervical training protocols that include both DCF muscle training and McKenzie neck training were more effective in reducing NP and neck disability than the protocols that used either DCF muscle training or McKenzie neck training alone in smartphone addicted users.

**CONFLICT OF INTEREST**

The authors declared that the present study was performed in absence of any conflict of interest.

**AUTHOR CONTRIBUTIONS**

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<tr>
<th>Authors’ contributions</th>
<th>KZF</th>
<th>WSM</th>
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<td>Collection of data</td>
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<td>Data interpretation</td>
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<td>Writing the article</td>
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<td>Final approval of article</td>
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